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Commission de contrôle de l'énergie atomique
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CANADIAN SUPPORT PROGRAM FOR INTERNATIONAL ATOMIC ENERGY AGENCY SAFEGUARDS

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Report

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CANADIAN SUPPORT PROGRAM FOR INTERNATIONAL ATOMIC ENERGY AGENCY SAFEGUARDS

ABSTRACT

Canada has established a safeguards research and development program, the purpose of which is to supplement the resources of the IAEA. The program of support is a coordinated effort for the development and application of safeguards techniques and instruments to facilities safeguarded by the IAEA. This document sets forth the progress in the program for 1985/86.

RÉSUMÉ

Le Canada a instauré un programme de recherche et de développement en matière de garanties dont le but est de suppléer aux ressources de l'AIEA. Le programme de soutien consiste en des efforts coordonnés dans la mise au point et l'application de techniques et d'instruments de garanties pour les installations assujetties aux garanties de l'AIEA. Le présent rapport décrit le progrès qui a été fait dans le programme durant 1985/86.

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INTRODUCTION

Canada supports international safeguards as a means by which the proliferation of nuclear weapons can be discouraged. Indeed, Canada was an early signatory of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and one of the first to accept International Atomic Energy Agency (IAEA) inspection in connection with the NPT. Canada recognizes that the IAEA must have effective safeguards techniques and the active cooperation of member states. As both a user and an exporter of nuclear power reactors and nuclear materials Canada also accepts an obligation to assist the IAEA in the development and application of effective safeguards.

For many years the IAEA has pursued, within its resource limitations, solutions to a number of safeguards problems. These concerns have been described in various Agency documents in particular the Safeguards Implementation Report which identifies difficulties encountered in the achievement of technical safeguards goals and objectives which limit the degree of confidence in the conclusion of non-diversion of nuclear material. Some of these problems relate to deficiencies in the technical measures for applying safeguards for various nuclear materials and facilities. To supplement the resources of the IAEA in these areas, the Canadian Government decided to initiate a safeguards research and development program. The first phase of the program which began in 1977 concentrated on safeguards approaches for on-load fueled reactors. In 1983 the program was expanded in scope to include bulk handling facilities, future Candu fuel cycles, storage facilities, and tasks of a more general nature.

The Canadian support program is a coordinated effort for the development and the application of safeguards instruments and techniques for nuclear facilities and materials. The projects undertaken are those requested by the IAEA, and the IAEA is involved at all stages of these projects. The program encompasses research, development, and applications engineering. Modifications that must be made to facility design for the incorporation of instruments and techniques are included.

To assist the IAEA in applying equipment and techniques developed under the Support Program, Canada provides cost-free experts to the IAEA. In the past, these cost-free experts have been employed in the Division of Development and Technical Support. The expanded scope of the Safeguards Support Program allows for the provision of cost-free experts in other areas. Other expert technical assistance for seminars and training is also made available when required.

ROLE OF CANADIAN ORGANIZATIONS

The Interdepartmental Committee on Safeguards (ICS), which has representatives from the Department of External Affairs, the Atomic Energy Control Board (AECB) and Atomic Energy of Canada Limited (AECL), considers and advises on many aspects of safeguards implementation and development. On behalf of Canada the ICS reviews and approves all new proposals for tasks under the Support Program and monitors the progress of each task.

The Department of External Affairs has a role in the overall direction of the program because of its responsibilities for Canadian nuclear non-proliferation policy. The AECB is the Canadian organization most familiar with the implementation of IAEA Safeguards because of its responsibility for cooperating with the IAEA in the implementation of the NPT safeguards agreement in Canada. AECL is the national nuclear research and development organization in Canada and has the capabilities for the development of safeguards equipment which is compatible with the design of nuclear facilities.

The AECB and AECL are jointly responsible for the administration of the Support Program. The following work is administered and funded through the AECB:

(a) provide and install safeguards equipment already agreed by Canada under the 1977 Support Program;

(b) develop safeguards schemes and techniques for other existing nuclear facilities in Canada, such as Pickering-B, Bruce-B, Darlington reactors and bulk handling facilities;

(c) recruit, train and arrange for experts to be attached to the IAEA under a Cost-Free Manpower Assistance Program;

(d) provide for travel of IAEA staff for general Support Program-related activities;

(e) provide nuclear chemical and physical standards required by the IAEA for safeguards development and application;

(f) undertake safeguard studies;

(g) ensure that the performance objectives and proposed method of operation of safeguards equipment developed under the Support Program are practical, cost-effective and in accord with the Canadian IAEA Safeguards Agreement if Canadian facilities are involved.

The following work is administered and funded through AECL:

(a) undertake R & D on safeguards equipment for facilities;

(b) undertake R & D on advanced safeguards equipment to improve the reliability, cost-effectiveness and performance of existing safeguards equipment;

(c) undertake R & D on safeguards schemes and safeguards equipment for a possible future advanced CANDU nuclear fuel cycle;

(d) undertake other scientific studies as agreed between Canada and IAEA.

In addition, AECL will normally serve as the prime contractor to the AECB for those portions of the work administered and funded by the AECB which require design, research, development, and workshop facilities.

FINANCIAL

The Support Program covers the direct and certain overhead costs of the program tasks. Financial administration of the Support Program is the responsibility of the AECB and AECL.

The cost of IAEA staff travel incurred in relation to program tasks or to attend meetings which are part of the Support Program are paid for by Canada.

All direct costs associated with the provision of expert manpower are borne by Canada. The IAEA and the AECB have agreed on a procedure by which the IAEA recovers these costs from Canada.

Unless otherwise stated, all costs in this document are expressed in Canadian dollars.

PROGRAM TASKS

The overall objective of the program described in this document is to assist the IAEA to develop suitable safeguards systems and equipment for implementation by the IAEA. The program has been subdivided into tasks so that it will be flexible and can be easily expanded or modified in the light of experience and changing requirements. Formal addition of new tasks to the program normally takes place at the semi-annual meetings between the IAEA and Canada. The list of approved tasks is now limited to those that can be started within two years from the nominal issuance of the list.

This document presents the project tasks in four categories: manpower assistance, system studies, equipment, and miscellaneous. The manpower assistance section includes cost-free experts and technical experts and technical expert assistance in the form of seminars and training. The tasks in the system studies section include the development of safeguards system concepts. The equipment section deals with tasks related to equipment specially designed for particular facilities. The fourth category, miscellaneous, is for those tasks, such as the provision of physical standards, which do not fit into one of the previous three groups.

The IAEA and the Canadian Support Program representatives meet semi-annually to review the program and the progress on individual projects and to bring the program document up to date.

SUMMARY OF PROGRESS DURING 1985/86

This report covers the period April 1, 1985 to March 31, 1986. The details of progress made on each task during 1985/86, including expenditure of funds, are provided in the individual reports for each task in the following sections. Highlights of the progress in the program for each group of tasks are given below.

1. Manpower Assistance

Six Cost-Free Experts provided assistance to the IAEA during the period. This was an increase of three over the previous year, reflecting continued satisfaction on the part of the IAEA with the contribution of the Support Program in this area.

The final draft of the safeguards scheme for NRX-type research reactors was issued within the IAEA as STR-147; a draft safeguards system analysis for gas-cooled on-load-fuelled reactors (OLRs) was produced; and a re-examination of safeguards applied to multi-unit CANDU power stations was initiated. Problems encountered with the introduction of the Computerized Inspection Report (CIR) for OLRs were addressed. A seminar on aspects of safeguarding CANDU reactors was presented by CFEs 1, 2, and 3 at the request of IAEA staff.

Training of inspectors on the operation of bundle counters and new types of seals was provided. The information sheets to record performance monitoring information were refined to obtain greater inspector acceptance of their use. The bundle counter operators manual was issued for comment. CFE-2 organized and produced the 1984/85 IAEA Safeguards Development Report. A draft of the IAEA ultrasonic seal field trial plan was prepared in conjunction with the equipment developers. Several performance monitoring visits were made.

CFE-5 provided final modifications to the event counter for the MUX CCTV system and assisted the IAEA in drafting specifications for the procurement of MUX CCTV systems by the IAEA.

Preliminary conclusions and recommendations were established with respect to enhancing the accuracy and reliability of NDA equipment for safeguards purposes. This work will be finalized in the next year.

A training course on the design, operation, and maintenance of bundle counters was provided to IAEA technical staff.

Expenditure $491,000.

2. System Studies

The final draft of the safeguards scheme for NRX-type research reactors was issued within the IAEA as STR-147. A review of safeguards approaches for multi-unit CANDU stations was initiated.

Expenditure $0.

3. Equipment

3.1 Bundle Counters:

The bundle counters installed in the CANDU 600 stations operated adequately. New geiger assemblies were installed and the software revised to reduce error messages. Some collimators have suffered from internal displacement of lead, which results in some error messages. An interim measure that produced good results was taken at the station with the most severe problem. A list of options and associated costs to provide a more permanent solution was in preparation at the end of the period.

Security cabinet doors have been redesigned to provide increased tamper resistance.

All four collimators were installed at Bruce 'A' generating station. The electronics have been fabricated. Installation of the guide tubes, junction boxes, and security cabinets is scheduled to be completed by December, 1986. The Bruce 'B' bundle counters performed well during the year. Assistance was provided to the IAEA in resolving some minor intermittent problems and an unusual sequence error.

A new design for the collimators for the Pickering 'A' bundle counters was produced and accepted by the IAEA and the station. Detailed mechanical design drawings were completed and delivered to the IAEA who used them to contract the manufacture of the collimators. The collimators should be installed in 1986. Pickering 'B' requires a different design of collimators than Pickering 'A'. Conceptual design and shielding and dose rate calculations for these collimators was completed.

Operator's manuals for all bundle counters were drafted and distributed for comment.

Expenditure $556,000.

3.2 Sealing Systems:

The analysis of seal signature data, including laboratory data at CRNL and the IAEA and data taken at NPD over one and a half years, indicated that an acceptable threshold value for acceptance or rejection of seal verification readings can be chosen. The next phase of the sealing program is to conduct a field trial at a reactor. Detailed planning for this field trial was the subject of continuing discussions between the AECB, AECL, IAEA, and station operators during the latter part of the year.

A transfer box and user's guide was delivered to the IAEA to permit the Agency to transfer the information from the SPAR seal reader to a personal computer. Development of a software specification for a seal signature archival and analysis system to be programed on the personal computer was under preparation at the end of the period.

The aluminum identity element chosen for the optical seal was found to corrode, galvanically, with the stainless steel body. Dielectrically isolating these components was proposed to overcome this problem. Initial tests indicated this solution was satisfactory, and the tests are underway to obtain information on the long-term stability of the optical seal. A laboratory prototype of the CCTV system for in-situ verification of the seal was found satisfactory by the IAEA. Work is continuing to complete documentation for the optical sealing system.

The IAEA approved the design of installation and removal tools for the X-type seal. Tests were initiated to investigate the degree of corrosion on the X-type seal and decontamination processes. Initial results indicated little or no corrosion and that simple decontamination procedures might be effective. These tests will be completed in 1986.

Most of the handling tools and components for the stack sealing system for the four CANDU 60's have been procured to provide sufficient sealing units for two reactor years of operation. The IAEA will procure hardware to meet needs in excess of that amount.

Minor modifications were made to stack covers at Gentilly-2 generating station to accommodate the full range of design tolerances. Misalignment of stacked fuel at the Pt. Lepreau station was greater than at Gentilly-2, and a new stack cover design was produced. This design will be discussed with the station operator for his approval.

Two papers on the seal system development were presented at the annual meeting of the Institute for Nuclear Materials Management.

Expenditure: $824,000.

3.3 Surveillance Devices:

The IAEA evaluated the laboratory prototype of the MUX CCTV surveillance system and noted two major concerns - drifting of the noise bar and a requirement for the frame counter to provide a tally for each camera as well as all eight cameras together. These, as well as several minor concerns, were incorporated to the Agency's satisfaction in a field trial unit originally scheduled for installation in Pt. Lepreau. At the Agency's request, this MUX CCTV system was provided to the IAEA for installation in another facility. Prior to shipment to Vienna, the field trial unit successfully passed a set of acceptance test procedures agreed to by the IAEA.

The Agency's satisfaction with the development of the MUX CCTV surveillance system is evidenced in their placing an order for six such systems apart from those to be supplied by the Support Program.

Expenditure: $514,000.

3.4 Verifiers:

The testing of the optical tool was put on hold until the IAEA tests its own system in the Bruce 'A' storage bay.

A summary report reviewing the development work performed on the Cerenkov Viewing Device (CVD) was produced. A draft operator's manual was provided to the IAEA. Measurements are scheduled to be performed in 1986 to confirm that the devices can meet the CANDU 600 performance requirements.

A feasibility study to verify the item count of fresh fuel stored in boxes without the need to open boxes has been initiated.

Expenditure: $258,000.

4. Miscellaneous:

A task was begun to write a computer program to provide stratified inventory listings for a Canadian storage facility containing large numbers of items of different material types. An initial listing was prepared and reviewed by the IAEA. Several comments were received which will be incorporated in the next revision.

Assistance was provided in revising the performance monitoring checklists and undertaking performance monitoring visits.

A small amount of warranty work was carried out on installed CANDU 600 safeguards equipment. This work has not been assigned to any particular task.

Expenditure: $101,000.

5. Program Expenditure 1985-86:

Total expenditure: 2,744,000

MANPOWER ASSISTANCE

Two types of projects are advanced in this section: cost-free experts (CFE) and engineering and scientific support (ECS). A cost-free expert in this program is a Canadian expert under contract to the IAEA under the terms of a special services agreement, all direct IAEA costs being reimbursed by Canada. The engineering and scientific support is primarily directed to the training of Agency personnel in an understanding of the operation of facilities of which Canada has particular expertise; and to assisting the Agency to apply safeguards schemes and equipment developed under the program.

CANADA/IAEA SAFEGUARDS SUPPORT PROGRAM

DESCRIPTION OF TASKS

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-1

TITLE: Safeguards System Analyst

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER: V. Pushkarjov

PROBLEM:

To develop and evaluate proposals for safeguards systems to be applied to OLRs.

PROPOSED SOLUTION:

Provide a Cost-Free Expert to:

1) Review Design Information
2) Make proposals for safeguards systems
3) Evaluate proposed safeguards systems
4) Develop criteria for safeguards system suited to OLRs
5) Liaise on system studies tasks

SCHEDULE AND MILESTONES:

Four cost-free experts have been consecutively supplied to serve on IAEA staff. The first cost-free expert was supplied to serve on IAEA staff in July 1978. A third expert served on staff from August 1983 to December 1985. He has been replaced by another CFE who began a two-year assignment in October 1985.

PROGRESS:

The final draft of the safeguards scheme for NRX-type research reactors was issued as STR-147. The draft safeguards scheme for NRU-type research reactors was revised and submitted for comment within the IAEA. As part of an Agency re-examination of safeguards on multi-unit CANDU generating stations begun in early 1986, a review of design information was performed, including site visits in Canada; a review of the current schemes and approaches, as implemented, was made; and an examination of alternative concepts, methods, and approaches was initiated. A draft safeguards system analysis for gas-cooled OLRs (STR-172) was produced for use as a basis for discussions on the implementation of safeguards at such reactors. A seminar on CANDU reactor safeguards was presented. The module for on-load-fuelled reactors for the inspector training course (ICAS) was presented twice. Problems encountered with the introduction of the Computerized Inspection Report were addressed. Assistance was provided with respect to the requirements and methodology for the safeguarding of reactor heavy water. General assistance to inspectors in the interpretation of the results obtained from safeguarding OLRs was provided. Considerable time was spent by the new expert in attending many modules in the inspector training course (ICAS).

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-1(cont'd)

PLANNED COMPLETION DATE:

Continuing

FUNDING:

Through 1983/84 -	$	474,000
1984/85 -	$	80,000
1985/86 -	$	121,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-2

TITLE: CANDU Safeguards Instrumentation Expert

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER: D. Rundquist

PROBLEM:

The IAEA requested assistance in the development of instrumentation for safeguarding CANDU reactors.

PROPOSED SOLUTION:

Supply a cost-free expert to serve on IAEA staff to:

1) Collaborate with IAEA staff in developing criteria for instrument performance
2) Collaborate with IAEA staff in determining needs for new instrumentation
3) Develop instruments as required, and participate in testing and evaluation
4) Interact with Canadian Support Program Office on task ESS-2

SCHEDULE AND MILESTONES:

The expert currently filling this task began his assignment in August 1985. An overlap was provided with his predecessor who completed his assignment in October 1985 to ensure continuity in the performance of the task.

PROGRESS:

During the year, a new CFE replaced the encumbent. The implementation of the performance monitoring program for the CANDU 600 equipment continues to be the responsibility of this CFE. The Performance Monitoring Site Package was revised and issued; site visits were scheduled; maintenance work was identified and scheduled; and performance monitoring visits were made. The IAEA 1984-85 Safeguards Development Report was organized and produced. Training of inspectors on the operation of the bundle counters was provided. The draft bundle counter Instruction Manual for Instrumentation (IMI) was revised and issued for comment. A lecture on the location, operation, and use of equipment was presented in the CANDU safeguards seminar. Assistance was provided, as requested, to Agency personnel concerning the operation of CANDU reactors and associated safeguards equipment. Input was provided in the drafting of the ultrasonic seal field trial plan.

PLANNED COMPLETION DATE:

August, 1987

FUNDING:

Through 1983/84 -	$	272,000
1984/85 -	$	84,000
1985/86 -	$	107,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-3

TITLE: CANDU Safeguards Implementation Expert

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER: D. Rundquist

PROBLEM:

The IAEA requested assistance with regard to design of CANDU power stations and research reactors to assist the implementation of safeguards equipment and ensure that a good knowledge of CANDU designs rests with the IAEA.

PROPOSED SOLUTION:

Supply a cost-free expert to serve on IAEA staff to:

1) Review design information now available with the IAEA
2) Recommend acquisition of additional data where required
3) Assist IAEA staff in the preparation of safeguard techniques and procedures
4) Assist IAEA staff in the preparation of instrument operation, and maintenance manuals

SCHEDULE AND MILESTONES:

The expert completed his assignment in February, 1986.

PROGRESS:

As a result of experience, the performance monitoring checklists were reorganized and streamlined. Several performance monitoring visits were undertaken, and important feedback was given to equipment developers and IAEA safeguards maintenance staff. Major input was made in providing solutions to the flow of lead in the bundle counter collimators. A contribution was made in the Seminar on CANDU safeguards. General assistance was provided to Agency staff in the understanding of possible diversion paths at CANDU 600s and the interpretation of results from safeguards instrumentation, particularly with respect to bundle counters. The first draft of the bundle counter Instruction Manual for Instrumentation (IMI) was prepared.

PLANNED COMPLETION DATE:

February, 1986

FUNDING:

Through 1983/84 -	$	249,000
1984/85 -	$	72,000
1985/86 -	$	93,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-5

TITLE: CCTV Expert

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER: E. Kerr

PROBLEM:

The IAEA requested assistance relating to closed circuit television surveillance systems for nuclear facilities.

PROPOSED SOLUTION:

Supply a cost-free expert to serve on IAEA staff to:

1) transfer multiplex time-lapse recorder (MUX-TLR) technology to the IAEA
2) install multiplex time-lapse CCTV surveillance systems
3) train inspectors and maintainers in the operation and use of CCTV equipment
4) participate in field deployment and performance monitoring
5) transfer the performance monitoring activity into routine use
6) suggest improvements shown to be necessary by field testing of equipment
7) produce appropriate documentation such as checksheets, inspection procedures, and instruction manuals for instrumentation
8) assist in establishing an appropriate maintenance system for surveillance systems

SCHEDULE AND MILESTONES:

Begin - November, 1985
Complete - November, 1987

PROGRESS:

Since beginning his assignment in November, 1985, the expert has worked on the final details of the MUX-CCTV system design with the developers, assisted in drafting specifications for the procurement of additional MUX-CCTV systems, performed other functions concerning the procurement of these systems in co-operation with the Section on Instrumentation, Methods and Techniques, and Agency Procurement Services.

PLANNED COMPLETION DATE:

November, 1987

FUNDING:

1985/86 - $ 40,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-6

TITLE: Seals Expert

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER: D. Rundquist

PROBLEM:

The IAEA requested assistance for a one-year period to direct the field installation and testing of seals developed by the Canada/IAEA Support Program and to continue the direction of on-going generic work on seals.

PROPOSED SOLUTION:

Supply a cost-free expert to serve on IAEA staff to:

1) organize field tests and eventual routine installation of seals at a number of facilities
2) establish performance monitoring programs for seals
3) establish procedures for use of seals
4) produce appropriate documentation such as checksheets and instruction manuals for instrumentation
5) establish a training program for inspectors on the use of seals

SCHEDULE AND MILESTONES:

Begin - January, 1986
End - December, 1986

PROGRESS:

The CFE began his assignment in January, 1986. The ultrasonic seal (ARC seal) field trial plan was drafted with the assistance of CFE-2. Twelve ARC seals were extensively tested to determine their suitability for the field trial. Work was begun on preparations for inspector training on the ARC/SPAR system. VACOSS III and Cobra seals under development by other Support Programs were distributed to the Operations divisions for field trials. Assistance was provided to Operations in the testing, training of inspectors, and application of these seals. General assistance to Operations and the Systems Studies Section was provided regarding tamper indication/protection requirements.

PLANNED COMPLETION DATE:

December, 1986

FUNDING:

1985/86 - $ 23,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-7

TITLE: Quality Assurance Expert

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER: J. Regnier

PROBLEM:

The IAEA requested assistance with regard to ensuring that NDA equipment provides the accuracy and reliability required for safeguards purposes and with regard to the development of evaluation criteria for inspection goal attainment.

PROPOSED SOLUTION:

Supply a cost-free expert to serve on IAEA staff to:

1) establish the appropriate Quality Assurance documentation to help ensure that NDA data obtained in the field provides the accuracy required for safeguards purposes by:

   i) researching the accuracy and reliability requirements for in-field use of NDA equipment
   ii) comparing data obtained in the field with the requirements
   iii) determining the reasons why the data obtained are not as good as that required
   iv) proposing and evaluating solutions to obtain appropriate NDA data in the field

2) further develop evaluation criteria for inspection goal attainment, particularly as applied to reactors by:

   i) assisting in the development of evaluation criteria for reactors using as a basis work done on that subject up to now
   ii) making a trial application of the developed criteria on specific examples of reactors, including on-load reactors
   iii) liaising with the working group in the Department of Safeguards that develops similar criteria for purposes of 90b statements

3) prepare periodic reports for management on the results of these activities

SCHEDULE AND MILESTONES:

Begin - October, 1985
End - October, 1987

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-7(cont'd)

PROGRESS

Since taking up his assignment in October, 1985, the expert devoted considerable time (about 2 months) in attending the inspector training course ICAS during which he had an opportunity to observe field measurements being made by inspectors under training at Seibersdorf Analytical Laboratories, a research reactor and a power reactor. Discussions were held with various staff members and the Agency Working Group on NDA to obtain information on the use of equipment, procedures to operate equipment, and results obtained. This enabled several preliminary conclusions and recommendations to be drawn which will be followed up in more detail in the next year.

Work on long-term criteria was begun by becoming familiar with some of the work performed to date.

PLANNED COMPLETION DATE:

October, 1987

FUNDING:

1985/86 - $ 49,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: ESS-1

TITLE: Seminars on Aspects of CANDU reactors

PARTICIPATING ORGANIZATIONS: AECL/AECB/Ontario Hydro

IAEA PROJECT OFFICER:

PROBLEM:

The limited information available to the IAEA on CANDU power stations was such that an understanding of safeguards schemes for these stations was not fully realized.

PROPOSED SOLUTION:

1) Provide the IAEA with a summary of information relevant to CANDU reactors.
2) Provide courses of instruction and seminars in Vienna on various aspects of CANDU power stations.

SCHEDULE AND MILESTONES:

Provide seminars as required on a non-routine basis.

PROGRESS:

The three-day CANDU Safeguards seminar was revised and presented by three of the CFEs in November, 1985.

PLANNED COMPLETION DATE:

Continuing.

FUNDING:

Through	1983/84 - $	17,000
	1984/85 - $	0
	1985/86 - $	0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: ESS-2

TITLE: Training in the Use of Safeguards Equipment

PARTICIPATING ORGANIZATIONS: AECB/AECL

IAEA PROJECT OFFICER:

PROBLEM:

Inspectors must be made aware of and trained in the use of new equipment developed by the Support Program so that the equipment is used in an effective manner.

PROPOSED SOLUTION:

1) Assist in preparing manuals and training aids.
2) Assist in conducting training courses to instruct inspectors.

SCHEDULE AND MILESTONES:

Continuing, as required.

PROGRESS:

A staff member of the IAEA Division of Development and Technical Support was trained at Chalk River Nuclear Laboratories in May, 1985 on the installation and operation of Kennertium geiger assemblies for bundle counters. Instruction on the software and interpretation of sequence errors was also provided for two specific versions of bundle counter programing.

A training course on the design, operation, and maintenance of bundle counters was provided to technical staff at IAEA headquarters in December, 1985. Nine sets of documentation for the course were provided to the IAEA. The course was considered by the IAEA to be successful and enabled the Agency to be in a position to maintain and service the bundle counters on their own.

Hardware for a training unit for phase II of the MUX CCTV system was procured. This unit will be used at IAEA headquarters in Vienna.

PLANNED COMPLETION DATE:

Continuing, as required.

FUNDING:

Through	1983/84 - $	25,000
	1984/85 - $	61,000
	1985/86 - $	54,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: ESS-3

TITLE: Attendance at Technical Meetings

PARTICIPATING ORGANIZATIONS: AECB/AECL/IAEA

IAEA PROJECT OFFICER:

PROBLEM:

IAEA staff need to consult with Canadian safeguards staff on technical matters relating to CANDU safeguards. This is best done by attending task force or working party meetings.

PROPOSED SOLUTION:

Fund IAEA participation in technical meetings concerned with tasks of the Safeguards Support Program.

SCHEDULE AND MILESTONES:

Continuing, as required.

PROGRESS:

Funds are authorized as required on a non-routine basis for IAEA personnel required for attendance at technical meetings.

PLANNED COMPLETION DATE:

Continuing, as required.

FUNDING:

Through 1983/84 -	$	138,200
1984/85 -	$	17,000
1985/86 -	$	4,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: ESS-4

TITLE: Review and Interpretation of Surveillance Records

PARTICIPATING ORGANIZATIONS: IAEA/AECB/AECL

IAEA PROJECT OFFICER:

PROBLEM:

The Agency requires assistance in training inspectors in the interpretation of surveillance records for CANDU reactors including the 600 MW CANDUs. The training film should illustrate routine operations occurring at the reactor facilities.

PROPOSED SOLUTION:

A feasibility study will be conducted to determine if a film of routine fuel handling operations can be made based on existing routine surveillance films or whether purpose-made films are required. The routine movements would include both fuelling and maintenance activities.

If feasible a review of surveillance films from Canadian facilities provided by the Agency will be made to select those portions which indicate typical routine movements. These portions will be put on a single tape with a description of the events that are occurring. If required these films may be supplemented by purpose-made films to show the entire sequence of each routine operation.

SCHEDULE AND MILESTONES:

Feasibility
Begin: October, 1985
Complete: March, 1985

Produce Film
Begin: January, 1987
Complete: July, 1987

PROGRESS:

An examination of existing routine surveillance videotapes indicated that a purpose made videotape would be required for the training film. Discussions with the IAEA indicated that using IAEA cameras would be preferred. A proposal to add a separate video recorder to obtain real time footage of the routine operations of the fuel handling equipment is required.

PLANNED COMPLETION DATE:

1987

FUNDING:

1985/86 - $ 0

SYSTEM STUDIES

Project tasks which fall into this section are those which relate to the determination of what would constitute an acceptable or adequate safeguards system for a particular type of facility. These projects are related to concepts rather than equipment. There are at least two steps required before a safeguards system can be put in place: the diversion analysis and the system design. While general rules may be applied, each facility type must be examined and considered individually.

System studies tasks relating to the 600 MW design have been undertaken and completed prior to the implementation of the support program. A diversion path analysis and a safeguards scheme were produced and provisionally accepted with minor modification by the IAEA. Equipment tasks relating to the 600 MW reactor were derived from the CANDU 600 system studies.

The tasks in this group are studies undertaken in cooperation with the IAEA. The actual implementation of a safeguards regime at a facility will depend upon agreements reached between the IAEA, the country in which the facility is located, and the facility operator.

CANADIAN SAGEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: S-2

TITLE: Development of a Safeguards Scheme for NRX-type reactors

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER:

PROBLEM:

A design for an integrated safeguard system is needed as a complement to IAEA inspection activities to provide a full safeguards package for NRX type research reactor.

PROPOSED SOLUTION:

To assist the IAEA to:

1) Compile design information
2) Produce a diversion analysis
3) Produce a safeguards scheme

SCHEDULE AND MILESTONES:

1) Begin September 1981
2) Produce a first draft for a safeguards scheme April 1983
3) Produce a second draft safeguards scheme June 1985
4) Produce a final safeguards scheme December 1985

PROGRESS:

A draft safeguards scheme for NRX-type reactors was issued within the IAEA as STR147. The IAEA has used the report as a reference for negotiating revised safeguards at one NRX-type reactor. Task complete.

PLANNED COMPLETION DATE:

February, 1986

FUNDING:

Through	1983/84 - $	1,000
	1984/85 - $	1,000
	1985/86 - $	0

CANADIAN SAGEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: S-7

TITLE: Development of a Safeguards Scheme for NRU-type Reactors

PARTICIPATING ORGANIZATIONS: AECB/AECL

IAEA PROJECT OFFICER:

PROBLEM:

A design for an integrated safeguards system for the NRU- type reactor is needed to complement the IAEA inspection activities to provide a comprehensive safeguards scheme for this type of reactor.

PROPOSED SOLUTION:

Assist the IAEA to:

1) Compile design information
2) Produce a diversion path analysis
3) Perform feasibility studies by providing technical assistance
4) Produce a safeguards scheme
5) Determine equipment needed for this safeguards scheme.

SCHEDULE AND MILESTONES:

Begin May 1982, complete 1985.

PROGRESS:

A draft safeguards scheme for NRU-type reactors was distributed within the IAEA for review and comment. All comments have not yet been received. The document, however, has been used as a reference in safeguards discussions to revise the safeguards implemented at one NRU-type reactor.

PLANNED COMPLETION DATE

April, 1985

FUNDING:

Through 1983/84 -	$	0
1984/85 -	$	2,000
1985/86 -	$	0

CANADIAN SAGEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: S-8

TITLE: Safeguards Scheme for Darlington

PARTICIPATING ORGANIZATIONS: IAEA/AECB

IAEA PROJECT OFFICER:

PROBLEM:

A safeguards system is required for the Darlington reactor facility.

PROPOSED SOLUTION:

Determine applicability of the Bruce A safeguards system to the Darlington facility by assisting the IAEA to:

1) Assemble appropriate information for Darlington
2) Determine if the safeguards scheme and equipment for Bruce A can be used for Darlington
3) Determine, if necessary, what changes in the Bruce A scheme or equipment would have to be made to allow them to be applied at Darlington

PROGRESS:

CFE-1 visited Canada in February, 1986 to review design information at utility headquarters and to determine that information which would be required to perform the safeguards study. In addition, he visited the construction site for the Darlington nuclear generating station to obtain additional information and familiarization with the station as constructed.

SCHEDULE AND MILESTONES:

1) Compile information for Darlington, February, 1986.
2) Compare Darlington and Bruce A designs, November, 1986.
3) Determine differences in the scheme required for Darlington, April, 1987.
4) Identify what design changes to the safeguards equipment designed for Bruce or to Darlington itself would be needed to adapt the Bruce scheme to Darlington. (A decision on proceeding with designing the necessary changes would be required before any redesign work is actually done.)
5) Write a report on the work done.

PLANNED COMPLETION DATE:

Complete milestone 3) April, 1987.

FUNDING:

Through 1984/85 - $ 1,000
1985/86 - $ 0

EQUIPMENT

Most of the equipment developed or under development fits into the category of containment and surveillance devices. Their use in safeguards can serve both to improve the assurance of non-diversion and to reduce the personnel requirements of the IAEA which has limited manpower resources.

Although the principles of operation of various kinds of safeguards equipment may be generally applicable, the specific design may be influenced by the facility type or even the individual facility design. Such equipment includes the bundle counter collimators, covers and seals, and the irradiated fuel verifier. Indeed much of this equipment may not be interchangeable from facility to facility, since not only will it be engineered to fit into a particular reactor type but also there are often minor differences between reactors within one type.

There are other pieces of equipment for which the design will be much less facility dependent. TV surveillance cameras and yes-no monitors fall into this category. In some cases assistance with the acquisition of this sort of equipment will be given under this support program.

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-2

TITLE: Provision of Bundle Counters for four 600 MW CANDU Stations

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: A. Keddar

PROBLEM:

The Agency requires counters for spent fuel bundles discharged from four 600 MWe CANDU reactors.

PROPOSED SOLUTION:

Manufacture, install and commission the bundle counters.

SCHEDULE AND MILESTONES:

Start manufacture : 1978
Complete installation : 1983
Complete commissioning: 1984
Deficiencies corrected: 1986

PROGRESS:

The bundle counters have been operating adequately in all four stations. The Geiger assemblies were redesigned to use Kennertium shielding and new cable connectors, and the sequence analysis software was revised. These modifications were incorporated at each station. IAEA and AECL have monitored the performance of the bundle counters.

Some collimators for the geigers suffered from internal displacement of lead which resulted in a few incorrect indications from the counters. Two collimators at one station were repaired with good results. A report was issued on the repair work, which included recommendations on alternative approaches to detect and, if necessary, correct the problem in the other collimators. After receiving comments, AECL has undertaken to revise the list of options for repairing the collimators. A decision concerning which alternative to follow will be made in conjunction with the IAEA.

The security cabinet doors were redesigned and an installation procedure drafted. The Agency will purchase and install doors of the new design for all the cabinets at all the CANDU stations that have or will have bundle counters.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84 - $ 720,000
1984/85 - $ 281,000
1985/86 - $ 144,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-3

TITLE: Provision of Bundle Counter for Bruce-A Station

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: A. Keddar

PROBLEM:

The Agency requires counters for spent fuel bundles discharged from the Bruce-A CANDU reactors.

PROPOSED SOLUTION:

Design, manufacture, install and commission the bundle counters. Except for software, the electronics and detectors will be the same as those at the 600 MWe CANDU stations.

SCHEDULE AND MILESTONES:

Design	:	1980-1983
Complete manufacture	:	1984
Complete documentation	:	1985
Complete installation	:	1985
Complete commissioning	:	1986

PROGRESS:

Installation of the Bruce A collimators was complicated due to the fact that the spent fuel bays were filled with water. Prior to installing the collimators, modifications were required to the gantry hoist beam and installation of a gantry crane extension beam. During removal of the upper shield blocks of the spent fuel handling equipment, it was found that modifications to the installation tool would be required. The modifications were implemented, and the shield blocks and X-frames removed. All four collimators are now installed at Bruce A. Installation of the guide tube junction boxes and the electronics cabinets remain to be done. The electronics cabinets are at site. The electronic components will be shipped to site upon installation of the electronics cabinets. The remaining work is scheduled to be completed by December, 1986.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84	- $	730,000
1985/85	- $	186,000
1985/86	- $	94,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-4

TITLE: Provision of Bundle Counters for Pickering-A Station

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: A. Keddar

PROBLEM:

The Agency requires counters for fuel bundles discharged from the Pickering-A CANDU reactors.

PROPOSED SOLUTION:

Design, manufacture, install and commission the bundle counters. Except for software, the electronics and detectors will be the same as those at the 600 MWe CANDU stations.

SCHEDULE AND MILESTONES:

Design	:	1980-1985
Complete manufacture	:	1986
Complete installation	:	1986
Complete commissioning	:	1987
Complete documentation	:	1987

PROGRESS:

A new design for the Pickering A bundle counter collimators was made that overcomes the problems identified by Ontario Hydro. The design replaces the lower shielding block in an existing duct access hatchway with collimator assemblies. The geiger assemblies are installed in the collimators by removable guide tubes to an upper shield block at floor level. Access to the duct is obtained by removing the geiger assemblies and guide tubes and collimator assemblies. The proposed design can be installed even if high radiation fields are present in the duct. Detailed mechanical design drawings were completed, and the drawings issued to the IAEA and Ontario Hydro. Shielding dose rate calculations were completed and a report issued. Ontario Hydro has reviewed and formally accepted the design. The IAEA has contracted for the manufacture of the collimators. The collimators should be installed in 1986. The IAEA has purchased the bundle counter electronics and will fund the installation costs.

PLANNED COMPLETION DATE:

1987

FUNDING:

Through 1983/84	- $	170,000
1984/85	- $	108,000
1985/86	- $	149,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-5

TITLE: Provision of Bundle Counters for 125 MW CANDU Station

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: A. Keddar

PROBLEM:

The Agency requires counters for spent fuel bundles being discharged from 125 MWe CANDU reactors.

PROPOSED SOLUTION:

Design and manufacture the bundle counter adapting the concept developed for the 600 MWe reactors to suit the 125 MWe reactor.

SCHEDULE AND MILESTONES:

Start and complete design	:	1982
Complete manufacture	:	1982
Ship to IAEA	:	1982
Supply spare parts	:	1985
Complete documentation	:	1986

PROGRESS:

New Kennertium geiger assemblies were supplied to the IAEA and installed. A review of results obtained from these bundle counters early in the year indicated a problem with the microprocessor program. Some of the observed irrational results were duplicated by CRNL, and revisions to the microprocessor code were made. The software changes were installed in new EPROMS that were given to the IAEA and installed in the bundle counters. For some unresolved reason, the new EPROMS generated multiple sequence errors on several transfers. The old EPROMS have been reinstalled. Work is underway to resolve the problems with the new software. An inspector's manual for these bundle counters has been drafted. It is being revised as a result of comments received.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84	- $	160,000
1984/85	- $	3,000
1985/86	- $	48,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-6

TITLE: Provision of Bundle Counters for 200 MW CANDU Station

PARTICIPATING ORGANIZATIONS: AECL-CRNL

PROJECT OFFICER: A. Keddar

PROBLEM:

The Agency requires assistance in the design of a counter for spent fuel bundles being discharged from a 200 MWe CANDU reactor, particularly with respect to physics calculations for the collimators and software for the electronics.

PROPOSED SOLUTION:

Design collimators and software to meet the specific technical conditions at the station. Manufacture special circuitry and spare parts.

SCHEDULE AND MILESTONES:

Start and complete design	:	1983
Supply spare parts and final documentation	:	1985

PROGRESS:

Results from the 200 MW bundle counters showed the electronics to be functioning properly. A minor problem due to corrosion of the connectors was corrected by replacing the geiger assemblies with Kennertium geiger assemblies, incorporating new connectors to prevent water ingress. An inspector's manual for the 200 MW bundle counter has been drafted and issued. The IAEA will provide cabinet doors of an improved design.

PLANNED COMPLETION DATE:

1985

FUNDING:

Through 1983/84	- $	330,000
1984/85	- $	11,000
1985/86	- $	40,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-7

TITLE: Engineering Assistance for Bundle Counters for Bruce-B Station

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: A. Keddar

PROBLEM:

The Agency requires engineering assistance in the design, development, installation and commissioning of spent fuel bundle counters for the Bruce-B station.

PROPOSED SOLUTION:

Provide assistance as required. Adapt the basic concept developed for the 600 MWe CANDU reactors to meet the requirements specific to Bruce-B.

SCHEDULE AND MILESTONES:

Start task	:	1984
Complete installation	:	1984
Complete commissioning	:	1985

PROGRESS:

In general, the Bruce B bundle counters worked well during the year. Assistance was provided to the IAEA in two areas: 1) intermittent problems were experienced that were identified as being caused by defective NIM-Planes on the electronics cabinets and 2) a single sequence error was reported that is apparently caused by unusually slow rotation of the scoop during an otherwise normal transfer of two bundles to the fuel transfer bay. An updated copy of the fuel bundle transfer sequence flow chart for the Bruce B counters was sent to the IAEA for their review which would explain the sequence error. The IAEA funded this work. The inspector's manual for Bruce A and B bundle counters is undergoing minor revisions arising from comments received.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84	- $	0
1984/85	- $	0
1985/86	- $	0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-8

TITLE: Engineering Assistance for Bundle Counters for Pickering-B Station

PARTICIPATING ORGANIZATIONS: AECL-CRNL-CANDU OPS

IAEA PROJECT OFFICER: A. Keddar

PROBLEM:

The agency requires engineering assistance in the design, development, installation and commissioning of spent fuel bundle counters for the Pickering-B station.

PROPOSED SOLUTION:

Provide assistance as required. The basic concept developed for the 600 MWe CANDU reactors is being adapted to meet the requirements specific to Pickering-B.

SCHEDULE AND MILESTONES:

Start task	:	1984
Complete installation	:	1985
Complete commissioning	:	1986

PROGRESS:

The Pickering B station has two fuel transfer ducts at each discharge bay instead of one, as in Pickering A. A different collimator design to eliminate radiation cross talk from the two transfer ducts is required. The shielding and dose rate calculations for the Pickering B collimators were completed and a report issued. The detailed mechanical design is nearing completion. The report and drawings will be sent to the IAEA and Ontario Hydro for approval.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84	- $	0
1984/85	- $	0
1985/86	- $	67,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-9

TITLE: Bundle Movement Simulator

PARTICIPATING ORGANIZATION: IAEA/AECL/AECB

IAEA PROJECT OFFICER:

PROBLEM:

The IAEA has identified a requirement for both training and troubleshooting purposes to have a bundle movement simulator with the ability to turn geiger currents on and off individually in any sequence and for durations of time ranging from fractions of a second to continuous. Such a simulator would enable the IAEA to demonstrate to inspectors the response of the bundle counter to such situations as:

1) A geiger tube failed permanently in the conducting state,
2) A geiger tube failure in the open circuit state,
3) Intermittent "on" and "open" circuit geiger states,
4) Unusual fuel discharge events.

PROPOSED SOLUTION:

1) Determine the feasibility of constructing the simulator,
2) Design, build and test the simulator.

SCHEDULE AND MILESTONES:

1) Determine feasibility of constructing the simulator,
2) Determine the cost of developing and constructing the simulator,
3) Develop and construct the simulator,
4) Test simulator,
5) Document the work, including operating and maintenance manuals,
6) Deliver simulator to IAEA.

PROGRESS

Work has been suspended on this task pending development work on a Mark II electronics version for the bundle counters.

PLANNED COMPLETION DATE:

To be determined.

FUNDING:

1985/86 - $ 0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-10

TITLE: Mark II Electronics for Bundle Counters

PARTICIPATING ORGANIZATIONS: AECL - CRNL

IAEA PROJECT OFFICER: A. Keddar

PROBLEM:

During the first two years of experience with the spent fuel bundle counters, the IAEA has identified improvements in the design of the electronics that would increase the reliability and usefulness of the bundle counters to IAEA inspectors.

PROPOSED SOLUTION:

1) prepare a specification for design of Mark II electronics for the spent fuel bundle counters for CANDU reactors
2) prepare a work plan for the development of the Mark II electronics
3) design, build, and test the bundle counter electronics
4) perform a field trial on the bundle counter electronics
5) finalize design and document manufacturing procedures
6) provide the IAEA with a prototype bundle counter electronics and one training unit

SCHEDULE AND MILESTONES:

1)	agree on the specification for the design of the Mark II bundle counter electronics -	December 1985
2)	prepare work plans for the development of a prototype Mark II electronics package -	December 1985
3)	design and build the bundle counter electronics	1986-87
4)	test the laboratory prototype -	1987
5)	document results and produce an operator's manual -	1987
6)	produce a manufactured prototype for field trial -	1987
7)	provide documentation to the IAEA on the design, manufacture, operation and maintenance of the bundle counter electronics -	1987
8)	provide the IAEA with a training unit -	1987
9)	perform a field trial of the bundle counter electronics -	1988

PROGRESS:

The specification for the Mark II electronics for the bundle counters has been drafted and transmitted to the IAEA. A work plan has been prepared.

PLANNED COMPLETION DATE:

1987

FUNDING:

1985/86 - $ 14,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: C-1

TITLE: Development of a Sealing System for the 600 MW CANDU Reactor Storage Bay

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: R. Dennys

PROBLEM:

Large numbers of spent fuel bundles accumulate in CANDU reactor spent fuel bays. It would be a difficult and time-consuming task to count and verify the bundles during a physical inventory verification at a CANDU station.

PROPOSED SOLUTION:

Develop a system for the 600 MWe CANDU stations to seal the spent fuel in storage racks. The sealing system will complement the surveillance system to provide continuity of knowledge regarding the nuclear material inventory. Sealing systems for other CANDU stations will be based on the experience gained at the 600 MWe stations.

SCHEDULE AND MILESTONES:

Start development: 1977
Complete development: 1986
Complete documentation: 1986

PROGRESS:

Repetitive readings were taken of the seals on a test rig in the NPD spent fuel storage bay to obtain data on the long-term reproducibility of seal signatures. The analysis of these data, along with data obtained in laboratories by AECL and the IAEA, indicate that an acceptable threshold level can be chosen that would result in a false-alarm probability of less than 10^{-3} for the ultrasonic seal signatures. The results from these experiments indicate that a true demonstration of the logistics of the sealing system should be conducted in an operating reactor. Detailed planning for this field trial has been the subject of continuing discussions between the IAEA, the AECB, and the station operator. The NPD tests have also resulted in minor modifications to some of the equipment, in particular, the seal lowering tray, the placement tool for the reading head, and the doughnut handling tool.

IAEA inspectors participated in the NPD tests for the first six months of the year. It was decided that further participation by the Agency inspectors was not cost effective.

The containment hardware, seal reading system tools, and support equipment were shipped to Gentilly-2 GS in preparation for the dry/wet trials of equipment and procedures prior to the field trial.

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: C-1(cont'd)

PROGRESS:

Problems were encountered with the quality control on the non-conventional thread design of the cap seals for the irradiated fuel containment assemblies. The seal/nut drawings were revised, and new thread gauges were ordered to ensure that all parts manufactured in future can be adequately inspected.

A rough cut for a training video tape for the application of the containment sealing hardware and the ARC ultrasonic seal reading system was prepared.

Revised software for the SPAR was implemented and tested so that the time required to implement the recommended procedures during routine seal verification would be substantially reduced. The improved software for the SPAR was transferred to the IAEA. A transfer box to permit the transfer of information from the SPAR to a storage system was purchased from Sandia National Laboratories in the United States for the IAEA. It was tested and forwarded to the IAEA. A user's guide was prepared for use with the transfer box for the CRNL data transfer and storage system, and a separate detailed interfacing guide for connecting the transfer box to a computer were prepared and transferred to the IAEA. Subsequent development of the transfer box software at Sandia National Laboratories has rendered much of this work obsolete. Hardware compatible with the computer-based ARC seal signature archival and analysis system under development at Sandia has been assembled at AECL. A software specification for the seal signature archival and analysis system is under development.

An interim report on the status of the ultrasonic seal system development is nearing completion. Two papers were presented at the twenty-sixth annual meeting of the Institute of Nuclear Materials Management.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84 -	$	1,460,000
1984/85 -	$	331,000
1985/86 -	$	434,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: C-2

TITLE: Provision of Sealing Systems for the Four 600 MW Station Storage Bays

PARTICIPATING ORGANIZATIONS: AECL-CRNL-CANDU OPS

IAEA PROJECT OFFICER: R. Dennys

PROBLEM:

A sealing system is required for the fuel in the spent fuel storage bay at each of four 600 MWe CANDU stations.

PROPOSED SOLUTION:

Design and manufacture the equipment required. The sealing system is based on connecting trays of spent fuel bundles together with rods and then sealing the rods in place with cap seals.

SCHEDULE AND MILESTONES:

Complete supply of stack covers and rods	:	1983
Complete demonstration and acceptance of seal	:	1985
Begin field use of sealing system	:	1986

PROGRESS:

Most of the components of the stack sealing system and the handling tools required for all four 600 MW stations have been procured to provide enough sealing units for the first two years of reactor operation. The IAEA will procure the
hardware for fuel discharged from reactors in excess of that procured by the Support Program. The implementation of the sealing systems at the reactors will depend on the success of the field trial of the ultrasonic seal project to start in 1986 at Gentilly-2. Modifications have been effected on the covers for the G-2 field trial so that any degree of misalignment of the stacks observed in the spent fuel bay should be accommodated. An entirely new cover design is being developed for the Pt. Lepreau spent fuel bay since the stacks at this station have a greater degree of misalignment than at the other three 600 MW stations. The seals to be installed at each of the reactors have not been procured since the results of tasks C-1 and C-6 must be evaluated to determine which seal will be installed for safeguards purposes.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84	- $	350,000
1984/85	- $	498,000
1985/86	- $	145,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: C-3

TITLE: Development of a Sealing System for the Irradiated Fuel Storage Bays for existing Canadian Supplied Reactors

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: R. Dennys

PROBLEM:

The Agency needs a sealing system for the spent fuel bays of existing Canadian supplied CANDU reactors.

PROPOSED SOLUTION:

Assist the Agency in designing and producing the equipment required for each particular reactor.

SCHEDULE AND MILESTONES:

Specify the scope of the task: 1987

PROGRESS:

No detailed work is planned until experience is gained with the CANDU 600 sealing system.

PLANNED COMPLETION DATE:

Not established.

FUNDING:

Through	1983/84 - $	26,000
	1984/85 - $	0
	1985/86 - $	0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: C-4

TITLE: Provision of a Sealing System for the Bruce-A Auxiliary Storage Bay

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: R. Dennys

PROBLEM:

The Agency needs a sealing system for the fuel in the auxiliary spent fuel storage bay at the Bruce A station.

PROPOSED SOLUTION:

Design and manufacture the equipment for sealing the spent fuel.

SCHEDULE AND MILESTONES:

Start design: 1979

PROGRESS:

The modifications to the as-built covers, required due to changes in the stacking frame dimensions, have been determined. Arrangements to modify the covers have been initiated with the mechanical maintenance group at Bruce G.S.

PLANNED COMPLETION DATE:

1987

FUNDING:

Through 1983/84 -	$	94,000
1984/85 -	$	20,000
1985/86 -	$	1,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: C-5

TITLE: Provision of a Sealing System for the Pickering-A Storage Bay

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: R. Dennys

PROBLEM:

The Agency needs a sealing system for the fuel in the spent fuel storage bay at the Pickering A station.

PROPOSED SOLUTION:

Design and manufacture the equipment for sealing the spent fuel.

SCHEDULE AND MILESTONES:

Start design: 1977
Install sealing equipment: 1987

PROGRESS:

The stacks and covers have been designed. The IAEA has approved the design and suggested one modification would be desirable. An approach has been suggested to the IAEA to meet the Agency request. Confirmation of Agency agreement on this approach has not been received.

PLANNED COMPLETION DATE:

1987

FUNDING:

Through	1983/84 - $	28,000
	1984/85 - $	0
	1985/86 - $	3,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: C-6

TITLE: Development of Alternative Seals for Spent Fuel Storage Bays

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: R. Dennys

PROBLEM:

The development of ultrasonic seals for use on stacks of CANDU fuel bundles in spent fuel storage bays has evolved into larger program than originally anticipated. There is a need for investigation of alternative approaches for seals that may be more readily applied in the field.

PROPOSED SOLUTION:

To offset the possibility that ultrasonic seals may not meet the Agency's requirements including tamper resistance, underwater seals based on other technologies are being developed.

An optical seal based on the unique crystal patterns and a seal incorporating the Agency's X-type seal are being proposed.

SCHEDULE AND MILESTONES:

Start task	:	1984
Demonstrate the sealing concepts	:	1984
Complete development	:	1985
Complete field demonstration	:	1987

PROGRESS:

Optical seal:

All effort was directed towards producing an aluminum identity element for the optical seal following the discovery that large crystal grains are present in as-cast 99.99% pure aluminum and that these grains appear radically different when illuminated from different directions. Early results indicated that the galvanic corrosion occurring between the aluminum identity element and the stainless steel body of the seal could prevent in-situ reverification of the seal after installation in the bay over time. The corrosion problem was overcome by electrically isolating the aluminum identity element from the stainless steel body by using insulating bolts and spacers and a heavily oxodized zircaloy non-return pin. Additional protection is achieved by anodizing the identity element in a solution of sulfuric acid. The effectiveness of these measures was confirmed by putting the new arrangement in a tank of distilled water for more than ten months after which no observable corrosion occurred. Additional testing has begun by installing twelve seals in

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: C-6(cont'd)

PROGRESS:

the spent fuel bay of the NRX research reactor. Preliminary results, after ten weeks, indicated no corrosion. These seals will be left in the bay to obtain information on the long-term stability of the corrosion resistance of the aluminum identity in the optical seal.

A laboratory prototype CCTV verification system for in-situ verification of the optical seal was fabricated. This system was demonstrated to the IAEA in October, 1985 and found satisfactory. Construction of two prototype field evaluation units was initiated, however, their manufacture has been delayed pending receipt of information on the IAEA CCTV camera that would be used in the verification unit.

Drafts of an optical seal status report and the optical seal user's manual were written. Work is continuing to complete documentation for the optical seal system, including engineering drawings, a complete system description, and a maintenance manual.

X-Type Seal:

Two prototype seal installation and removal tools were tested and demonstrated to the IAEA. The design of one of the prototypes was preferred by the IAEA over the other. A field trial prototype set of tools of the preferred design was fabricated. A second set of tools, about one meter long, was manufactured for shipment to the IAEA for training purposes. Both sets of tools have been tested and are ready for use. A procedure to assemble the X-type seal on the seal nut was developed, and a new crimp application tool was designed and fabricated.

Because of corrosion problems of the top element of the X-type seal, it was recommended to the IAEA that the top be made of a different material - type 17-4 PH stainless steel. Coupons of X-type seal component alloys were submersed in the NPD spent fuel bay for a period of three months to investigate decontamination processes and the degree of corrosion that occurred. Preliminary results indicated little corrosion and that brushing in distilled water was an effective decontamination procedure.

Drafts were completed for a development report describing the work done to date on the seal and related tooling; on an inspector's manual for installing, checking, and removing the seals; and a proposal for a full-cycle test in the NRU spent fuel bay involving IAEA personnel.

PLANNED COMPLETION DATE:

1987

FUNDING:

Through	1983/84 - $	500,000
	1984/85 - $	367,000
	1985/86 - $	241,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-2

TITLE: Provision of Irradiated Fuel Verifiers for Four 600 MW CANDU Stations

PARTICIPATING ORGANIZATIONS: AECL/AECB

IAEA PROJECT OFFICER:

PROBLEM:

Provision of irradiated fuel verifiers for four 600 MWe CANDU stations.

PROPOSED SOLUTION:

1) Ensure design of prototype (V-8) is adequate
2) Modify if required to suit particular installations
3) Construct four sets of verifiers
4) Provide design, operation and maintenance manuals
5) Provide a training program for IAEA staff on the operation of the equipment

SCHEDULE AND MILESTONES:

Begin July, 1983
Complete 1986

PROGRESS:

A decision to proceed with delivery of these devices to the IAEA is awaiting completion of Task V-8.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through	1983/84 - $	84,000
	1984/85 - $	32,000
	1985/86 - $	0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-3

TITLE: Provision of Irradiated Fuel Verifiers for Existing Canadian Supplied Reactors

PARTICIPATING ORGANIZATIONS: AECL/AECB

IAEA PROJECT OFFICER:

PROBLEM:

Provision of irradiated fuel verifiers for existing Canadian supplied reactors.

PROPOSED SOLUTION:

To assist the IAEA to produce an irradiated fuel verifier suited to irradiated fuel storage bays at CANDU reactors. Such devices must be designed to suit the particular parameters of each storage bay. The agency will be assisted to:

1) Design verifiers and tools
2) Construct verifiers and tools

SCHEDULE AND MILESTONES:

As requested by the IAEA.

PROGRESS:

The scope of this task is still under discussion with the IAEA and is pending development of safeguards schemes for the reactors in question and completion of task V-8.

PLANNED COMPLETION DATE:

To be determined.

FUNDING:

Through 1983/84 - $ 0
1984/85 - $ 0
1985/86 - $ 0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-4

TITLE: Provision of an Irradiated Fuel Verifier for Bruce-A Station

PARTICIPATING ORGANIZATIONS: AECL/AECB

IAEA PROJECT OFFICER:

PROBLEM:

Provision of irradiated fuel verifier suited to the Bruce A station storage bay. Such a device must be designed to suit the particular parameters of the bay.

PROPOSED SOLUTION:

The agency will be assisted to:

1) Determine IAEA requirements
2) Design verifier and tools
3) Construct verifier and tools
4) Install and test

SCHEDULE AND MILESTONES:

Begin April 1978
Complete 1987

PROGRESS:

1) A program has been initiated for the development and manufacture of an optical type verifier for the fuel bundles in the Bruce primary bay (Task V-6)
2) The development work concerning the Cerenkov verifier for spent fuel (Task V-8) indicates that such devices may also be applicable for this type of power station.

PLANNED COMPLETION DATE:

1987

FUNDING:

Through 1983/84 - $ 48,000
1984/85 - $ 0
1985/86 - $ 0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-6

TITLE: Development of an Optical Tool for Bruce-A Storage Bay

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER:

PROBLEM:

The system studies safeguards scheme for the Bruce A power station recommended an optical tool as a back-up measure for the primary storage bay to verify the number of fuel bundles stored in the bay. The optical tool must be capable of detecting empty positions in stacked trays of irradiated fuel bundles.

PROPOSED SOLUTION:

To develop and demonstrate a tool which can detect whether or not a storage site is filled in any tray location in the Bruce A primary storage bay. Assistance will be provided to the agency to:

1) Design the tool
2) Produce a prototype tool
3) Test tool and demonstrate to the IAEA
4) Based on test and demonstration produce, install and commission an operational version of the tool.

SCHEDULE AND MILESTONES:

Start April, 1981
Complete 1986

PROGRESS:

The CCTV system with integrated indexing mechanism has not been tested in the spent fuel bay. The IAEA requested that this project be put on hold until it has tested its own system in the Bruce A storage bay.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through	1983/84 - $	27,000
	1984/85 - $	19,000
	1985/86 - $	0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-8

TITLE: Application of Cerenkov Glow Amplification Techniques as an Attribute Test for Irradiated Fuel in 600 Mw CANDU Storage Bays.

PARTICIPATING ORGANIZATIONS: AECB/AECL

IAEA PROJECT OFFICER: S. Sanatini

PROBLEM:

Work on project V-7 has indicated that a technique which measures Cerenkov radiation has a good potential to satisfy the requirements of a spent fuel attribute test. The feasibility of, and a design for, the practical use of Cerenkov radiation techniques as a qualitative attribute test for unsealed irradiated fuel in 600 Mw CANDU spent fuel storage bays must be demonstrated under bay lighting conditions required for operational safety considerations.

PROPOSED SOLUTION:

1. Evaluate Cerenkov glow detection techniques that can be implemented under normal bay lighting conditions

2. Determine a performance specification for the Cerenkov Viewing Device (CVD) to be used in the 600 Mw CANDU safeguards scheme

3. Develop a CVD that will meet the performance specification

4. Write a report documenting the capabilities and limitations of the CVD

5. Provide design, operating, and maintenance manuals for the CVD

SCHEDULE AND MILESTONES:

Start April 1980
Complete 1986

PROGRESS:

A summary report which reviews all the work performed on the development of the CVD for use as an attribute verifier of irradiated fuel in CANDU 600 spent fuel storage bays was completed and given to the IAEA. A draft operator's manual for using the Mark I, II, and III CVD devices was completed and provided to the IAEA for review and comment. Theoretical calculations were performed to model the production of Cerenkov light of CANDU fuel stored in spent fuel bays. The results of the calculations show excellent agreement with experimental data. A report on the results of the calculations was begun. Completion of the status

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-8(cont'd)

PROGRESS:

report, the operator's manual, and the theoretical calculations resulted in a request from the IAEA to perform a final set of measurements at a CANDU 600 spent fuel bay to confirm that the devices developed can meet the performance requirements for Task V-8. To this end, Pt. Lepreau generating station was provided with the objectives of the work, a description of the activities, and a work schedule for performing the measurements. It is expected that the measurements will be performed in 1986.

PLANNED COMPLETION DATE:

September, 1986

FUNDING:

Through 1983/84 -	$	352,000
1984/85 -	$	23,000
1985/86 -	$	170,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-9

TITLE: Application of Cerenkov Glow Amplification Techniques as an Attribute Test for Irradiated Fuel in Storage Bays.

PARTICIPATING ORGANIZATIONS: AECB/AECL

IAEA PROJECT OFFICER: S. Sanatini

PROBLEM:

Work on project V-7 has indicated that a technique which measures Cerenkov radiation has a good potential to satisfy the requirements of a spent fuel attribute test. Cerenkov Viewing Devices have been developed to detect the Cerenkov glow emitted from spent fuel. The further capabilities and limitations of these devices have not been established.

PROPOSED SOLUTIONS:

1. Calculate and validate theoretical Cerenkov glow intensities for various burn-ups and cooling times

2. Evaluate the CVDs with respect to spent CANDU fuel according to:

    a) sensitivity (cooling time and burnup)
    b) adjacent bundle interference
    c) lighting conditions
    d) ability to produce standardized results

3. Write a report describing the capabilities and limitations of the CVD as an attribute verifier for spent CANDU fuel

4. Provide recommendations for changes in CVD design

5. Provide design, operation, and maintenance manuals

6. Evaluate CVDs for spent fuel other than CANDU in applications agreed between Canada and the IAEA

SCHEDULE AND MILESTONES:

Begin March, 1985
Complete 1987 (proposed Solutions 1, 2, 3, 4, 5)

PROGRESS:

Work plans and schedules for future work under this task were drafted. Theoretical calculations were extended to bundles with long cooling times. A calibrated light source was purchased for the calibration of CVDs. Work began on the measurement of the spectrum of this source. A new CVD, Mark IV, was purchased. It was intended to have a variable gain adjustment, but this feature was not included on the device. It will be replaced by the manufacturer.

FUNDING:

1985/86: $ 80,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SC-5

TITLE: Development of a Multiplexed CCTV Surveillance System for the 600 MW CANDU Reactor

PARTICIPATING ORGANIZATIONS: AECL-CANDU OPS

IAEA PROJECT OFFICER: P. Vodrazka

PROBLEM:

When the CCTV system for the 600 MWe CANDU reactors was developed, video disc storage was used to meet the specifications. The reliability of the equipment has proven to be unsatisfactory.

PROPOSED SOLUTION:

The technology for time lapse video recorders (TLR) now offers the opportunity to design a CCTV system that can be both more reliable and less expensive than the original system. A system based on TLRs will be developed.

SCHEDULE AND MILESTONES:

Start development : 1983
Demonstrate a prototype: 1985
Complete development : 1986
Complete documentation: 1986

PROGRESS:

The IAEA completed its testing of the laboratory prototype and produced a report on its evaluation of the system. Two major concerns were noted by the IAEA. The first involved problems in review caused by the noise bar which had a tendency to drift. The drifting caused irritation to the inspector during tape review and interfered with the frame counter. The other major comment by the Agency was that the frame counter should provide the total number of frames for each camera and for the total system rather than only the latter. Two multiplex CCTV systems were assembled and tested. One is a field trial unit to be tested by the IAEA, and the other is a unit to stay at Sheridan Park as a reference system. These two systems incorporate comments and suggestions resulting from the Agency testing, including a new frame counter. A reduction in the interference caused by the noise bar on tape review has been achieved. The noise bar has not been eliminated, but its position can be controlled, and it remains stable. Consequently, it does not interfere with frame counting, and distraction to the observer is minimal.

Acceptance test procedures for the MUX CCTV system were drafted and agreed to by the IAEA.

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SC-5(cont'd)

PROGRESS:

A second phase for the development of the MUX CCTV system is the provision of a monitoring computer to assist the inspector in performance monitoring of the system and in reviewing tape. The first stage of phase II is a minimum-scope demonstration to illustrate the concept and capabilities of the monitoring system to the IAEA. Hardware for this demonstration system was assembled. Software was written and documented. Individual sensors have not been procured. However, simulation of different sensors was provided in order to demonstrate the software. Preliminary comments from the IAEA were positive regarding the development of this monitoring computer. The hardware will be repackaged and sent to the IAEA who will evaluate the hardware and software for this stage of development.

The Panasonic NV8050 time lapse recorders that are in the original multiplex design are no longer being fabricated by the manufacturer. A replacement model, the Panasonic AG-5060, was procured for detailed evaluation to determine if it could be used as a replacement in the MUX CCTV system.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84 -	$	180,000
1984/85 -	$	444,000
1985/86 -	$	380,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SC-6

TITLE: Provision of a Multiplexed CCTV Surveillance System for four 600 MW CANDU Reactors

PARTICIPATING ORGANIZATIONS: AECL-CANDU OPS

IAEA PROJECT OFFICER: P. Vodrazka

PROBLEM:

The original CCTV systems installed at the 600 MWe CANDU reactors have been insufficiently reliable.

PROPOSED SOLUTION:

Replace the original CCTV systems with new ones based on multiplexed time lapse recorders. In the meantime, use TLRs as back-ups in the existing systems.

SCHEDULE AND MILESTONES:

Install back-up TLRs : 1984
Replace original systems with multiplexed TLR systems: 1986

PROGRESS:

A field trial unit was fabricated and scheduled for use at Pt. Lepreau. This unit incorporates all comments and suggestions made by the IAEA after its testing of the laboratory prototype. The field trial unit successfully passed the acceptance test procedures at the manufacturer's facility and was delivered to the IAEA for installation in a facility.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84 - $ 0
1984/85 - $ 26,000
1985/86 - $ 133,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SC-7

TITLE: Surveillance System for 200 MW Fuelling Machine Room

PARTICIPATING ORGANIZATIONS: IAEA/AECL/AECB

IAEA PROJECT OFFICER:

PROBLEM:

The IAEA has identified a need to detect abnormal fuel transfers in the fuelling machine room of 200 Mw reactors and to correlate this information with other safeguards information.

PROPOSED SOLUTION:

Investigate the use of surveillance in the 200 MW CANDU fuelling machine room by examining such possibilities as periscopes, telescopes, wide angle lenses, fibreoptics, CCTV, film cameras etc. Problems of inaccessibility of the fuelling machine vaults while the reactor is operating must be considered.

SCHEDULE AND MILESTONES:

Start task:	December, 1984
Complete investigation:	October, 1985
Write report:	March, 1986

PROGRESS:

The investigation of the use of surveillance at 200 MW CANDU fuelling machine rooms was completed. The IAEA was informed of the results of the investigation.

PLANNED COMPLETION DATE:

1986

FUNDING:

1985/86 - $ 1,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: FF-4

TITLE: Provision of Fresh Fuel Counters for the Bruce-A CANDU Station

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER:

PROBLEM:

The IAEA requires four fresh fuel counters for the Bruce type CANDU generating station.

PROPOSED SOLUTION:

To assist the IAEA to produce fresh fuel counters for the Bruce generating station. Four production fresh fuel counters will be constructed.

SCHEDULE AND MILESTONES:

Begin January, 1984

PROGRESS:

Four fresh fuel counters have been manufactured. Installation awaits IAEA re-examination of the safeguards scheme for Bruce A.

PLANNED COMPLETION DATE:

1986

FUNDING:

Through 1983/84 -	$	65,000
1984/85 -	$	4,000
1985/86 -	$	1,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: FF-5

TITLE: Fresh Fuel Verifier

PARTICIPATING ORGANIZATIONS: IAEA/AECB/AECL

IAEA PROJECT OFFICER:

PROBLEM:

The IAEA has identified a need to verify the item count of fresh fuel stored in boxes without the need to open boxes or remove them from their storage locations.

PROPOSED SOLUTION:

1) Perform a feasibility study to determine a method to verify the item count of fresh fuel in boxes without opening the boxes or removing them from their storage locations

If 1) yields positive results

2) Develop a laboratory prototype instrument to perform the verification
3) Demonstrate prototype to IAEA

SCHEDULE AND MILESTONES:

1) Perform feasibility study to identify possible solutions
2) Evaluate the solutions giving priority to those that use IAEA instrumentation accepted for routine use
3) Write a report of the finding of 1) and 2)

If feasible

4) Develop a laboratory prototype
5) Demonstrate prototype to IAEA
6) Document the work, including operating and maintenance manuals
7) Deliver prototypes to IAEA for evaluation

PROGRESS:

A work statement to obtain a contractor to perform the feasibility study has been drafted.

PLANNED COMPLETION DATE:

Complete feasibility study 1986

FUNDING:

1985/86 - $ 7,000

MISCELLANEOUS

The tasks which appear in this section are those which do not logically fall into the previous three program areas although they may be of equal importance. This section includes the provision of physical standards, engineering and technical support and various feasibility studies.

CANADIAN SAFFGUARDS R & D IN SUPPORT OF IAEA

TASK NO: PI-1

TITLE: Stratified Facility Inventory List for MBA-CNA1

PARTICIPATING ORGANIZATIONS: AECB/AECL-CRNL

IAEA PROJECT OFFICER: R. Thiele

PROBLEM:

The inventory of MBA-CNA1 contains several thousand items of a variety of different material types. It takes about 8 hours of inspector time to stratify the inventory for IAEA sampling procedures, and there are 12 inspection per year. The inspector's and operator's time could be put to better use.

PROPOSED SOLUTION:

Write a suitable program for the facility computer to produce a stratified inventory list.

SCHEDULE AND MILESTONES:

1) agree with IAEA on scope of task - September, 1985
2) begin programing - October, 1985
3) provide stratified inventory to IAEA - March, 1986

PROGRESS:

The scope of the task was agreed. The IAEA provided a format for the listing. A listing was produced in March, 1986. The IAEA noted several minor points which will be addressed in the next fiscal year.

PLANNED COMPLETION DATE:

1986

FUNDING:

1985/86 - $ 5,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: PS-1

TITLE: Provision of Physical Standards

PARTICIPATING ORGANIZATIONS: AECB/AECL

IAEA PROJECT OFFICER:

PROBLEM:

The IAEA requires access to nuclear material standards in order to provide the basis for measurements made during the course of its verifications.

PROPOSED SOLUTION:

Provide standards or facilities for measurement of standard items.

SCHEDULE AND MILESTONES:

As required

PROGRESS:

No IAEA requests were received in 1985/86.

PLANNED COMPLETION DATE:

On-going

FUNDING:

Through 1983/84 -	$	2,000
1984/85 -	$	0
1985/86 -	$	0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: TS-1

TITLE: Provision of Scientific and Engineering Technical Support

PARTICIPATING ORGANIZATIONS: AECB/AECL

IAEA PROJECT OFFICER:

PROBLEM:

The application of new concepts and new techniques to safeguards often requires testing and development before a prototypical instrument or installation can be designed and, in many cases, this requires sophisticated practical instrumentation. The IAEA needs Canadian assistance when such concept testing must be undertaken under conditions in which Canada has unique expertise.

PROPOSED SOLUTION:

1) Upon request, consult with the IAEA to identify the requirements of the concept testing/demonstration
2) In consultation with the IAEA make the necessary arrangements to conduct the tests/demonstration
3) Undertake the test/demonstration
4) Report results

SCHEDULE AND MILESTONES:

As required

PROGRESS:

During 1985/86, the performance monitoring was the only assistance requested under this task.

Because much of the equipment installed in the 600 MW reactors was not able to be environmentally tested prior to installation, a performance monitoring program was initiated to provide information on the reliability of the instrumentation in operating reactors. This work was primarily performed by cost-free experts and personnel from the Division of Development and Technical Support of the IAEA in the early stages. The information will eventually be gathered by inspectors and analyzed by IAEA staff.

FUNDING:

Through 1983/84	- $	112,000
1984/85	- $	68,000
1985/86	- $	55,000

COMPLETE OR TERMINATED TASKS

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CFE-4

TITLE: Documentation Specialist and Heavy Water Instrumentation Expert

PARTICIPATING ORGANIZATIONS: AECL/AECB

IAEA PROJECT OFFICER: E. Kerr

PROBLEM:

The IAEA requested assistance in setting up a documentation storage and retrieval system with respect to the technical material - drawings, manuals, and specifications - that are associated with the equipment developed by the support programs for the IAEA and assistance relating to the safeguards of heavy water at reactors and storage facilities.

PROPOSED SOLUTION:

Supply a cost-free expert to serve on IAEA staff to:

1) Set up a technical document storage and retrieval system suitable for computer usage.
2) Advise and collaborate with IAEA staff in the development of methods for verifying the heavy water inventory at reactors and storage locations.

SCHEDULE AND MILESTONES:

A cost-free expert to begin a one-year assignment in October, 1984.

PROGRESS:

The expert completed the documentation task by identifying all those documents held by the IAEA associated with tasks performed by the Canada/IAEA Safeguards Support Program. A list of those documents not held by the IAEA was prepared and distributed to Canadian authorities for subsequent transmittal of these documents to the IAEA. A document indexing system was established. Recommendations for a document storage and retrieval system was presented to the IAEA. It was decided that other approaches would be used to provide the assistance on heavy water safeguards rather than use the services of a CFE.

PLANNED COMPLETION DATE:

Complete February, 1985

FUNDING:

1984/85 - $ 29,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: S-1

TITLE: Development of a Safeguards Scheme for 125 MW CANDU Reactors

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER:

PROBLEM:

A design for a safeguard system for 125 MWe CANDU reactors is needed as a complement to IAEA accounting activities to provide comprehensive safeguards for such reactor facilities.

PROPOSED SOLUTION:

To assist the IAEA to:

1) Compile design information
2) Produce a diversion path analysis
3) Produce a total safeguards scheme for the facility
4) Determine the equipment required for upgrading of safeguards at these facilities

SCHEDULE AND MILESTONES:

Begin January, 1981

PROGRESS:

1) a safeguards scheme was produced and a report drafted by the IAEA
2) an irradiated fuel bundle counter has been developed and shipped to the IAEA for use in this reactor type
3) a sealing system was designed by the IAEA and a prototype constructed and tested in collaboration with AECL

PLANNED COMPLETION DATE:

April, 1983

FUNDING:

Through 1983/84 - $ 50,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: S-3

TITLE: Development of a Safeguards Scheme for 200 MW CANDU reactors

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER: W. Bahm

PROBLEM:

A design for an integrated safeguard system is needed as a complement to current IAEA inspection activities to provide comprehensive safeguards for 200 MWe CANDU reactors.

PROPOSED SOLUTION:

Assist the IAEA to:

1) Compile design information
2) Produce a diversion analysis
3) Produce a safeguard scheme
4) Determine the equipment required for upgrading of safeguards in this reactor type.

SCHEDULE AND MILESTONES:

Begin July, 1981, complete December, 1983

PROGRESS:

The IAEA has been supplied with a diversion path analysis for these reactor types. The IAEA project officer for this task visited Canada in 1981 to study this reactor. Recommendations were made for upgrading of safeguards in this type of reactor in an IAEA internal report.

PLANNED COMPLETION DATE:

Complete

FUNDING:

Through 1983/84 - $ 43,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: S-4

TITLE: Development of a Safeguards Scheme for Bruce-A Station

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER:

PROBLEM:

A design for an integrated safeguard system for the Bruce A CANDU power station is needed as a complement to current IAEA inspection activities to provide comprehensive safeguards for the Bruce A reactor facility.

PROPOSED SOLUTION:

Assist the IAEA to:

1) Compile design information
2) Produce a diversion path analysis
3) Provide technical assistance to the IAEA as needed including feasibility studies
4) Produce a safeguard scheme

SCHEDULE AND MILESTONES:

Begin April 1, 1979, complete March, 1981

PROGRESS:

The safeguards equipment feasibility study was completed and sent to the IAEA. A diversion path analysis was sent to the IAEA. The proposed safeguard scheme has been prepared by the IAEA. Development work was indicated as being required on core input monitors, bundle counters, seals for spent fuel, Cerenkov verifiers and an optical verifier for checking of fuel in the primary storage bay.

PLANNED COMPLETION DATE:

Complete

FUNDING:

Through 1983/84 - $ 80,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: S-5

TITLE: Development of a Safeguards Scheme for Pickering-A Station

PARTICIPATING ORGANIZATIONS: AECB

IAEA PROJECT OFFICER:

PROBLEM:

A design for an integrated safeguards system is needed as a complement to current IAEA accounting activities to provide comprehensive safeguards for the Pickering A reactor facility.

PROPOSED SOLUTION:

Assist the IAEA to:

1) Compile design information
2) Produce a diversion path analysis
3) Provide technical assistance to the IAEA as needed including feasibility studies
4) Produce a safeguards scheme for the facility

SCHEDULE AND MILESTONES:

Begin April 1, 1980, complete March, 1981

PROGRESS:

The IAEA indicated a feasibility study of existing safeguards equipment would be required and that a diversion path analysis would not be needed. The IAEA were provided with all design information required for the development of a safeguards scheme. A proposed safeguards scheme has been prepared. Development of bundle counter electronics and underwater seal for spent fuel were recommended in the proposed scheme.

PLANNED COMPLETION DATE:

Complete

FUNDING:

Through 1983/84 - $ 5,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: S-6

TITLE: Development of a Safeguards Scheme for WR-1-type Reactors

PARTICIPATING ORGANIZATIONS: AECB/AECL

IAEA PROJECT OFFICER: W. Bahm

PROBLEM:

A design for an integrated safeguard system for WR-1-type organic CANDU reactors is needed as a complement to IAEA inspection activities to provide comprehensive safeguards for this reactor type.

PROPOSED SOLUTION:

Assist the IAEA to:

1) Compile design information
2) Produce a diversion path analysis
3) Provide technical assistance to the IAEA as needed including feasibility studies
4) Produce a safeguards scheme
5) Make recommendations regarding equipment to be used in conjunction with the safeguard scheme

SCHEDULE AND MILESTONES:

Begin September, 1981, complete July, 1985

PROGRESS:

Design information has been compiled and sent to the IAEA. The IAEA project officer for this task visited Canada in 1981 to study this type of reactor. A review of design information was undertaken by CFE-1 in June, 1983. This task has been terminated since no WR-1 type reactor will be in service after 1985.

PLANNED COMPLETION DATE:

Terminated

FUNDING:

Through 1983/84 - $ 3,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: B-1

TITLE: Development of a Bundle Counter for the 600 MW CANDU Reactors

PARTICIPATING ORGANIZATIONS: AECL-CRNL

IAEA PROJECT OFFICER: A. Keddar

PROBLEM:

The Agency needs assurance that the number of fuel bundles discharged from the core of a 600 MW CANDU reactor and transferred to the spent fuel storage bay is in agreement with the operator's records.

PROPOSED SOLUTION:

Develop a spent fuel bundle counter suitable for the 600 MW CANDU reactor.

SCHEDULE AND MILESTONES:

Start development	:	1977
Complete development	:	1982
Complete documentation	:	1982

PROGRESS:

A suitable bundle counter has been developed and demonstrated to the Agency. Detailed design and operating documentation have been completed.

PLANNED COMPLETION DATE:

Complete 1982

FUNDING:

Through 1983/84 - $ 840,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-1

TITLE: Development of an Irradiated Fuel Verifier for 600 MW CANDU Reactors

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER:

PROBLEM:

In order to determine that no diversion of irradiated fuel has occurred from the storage bay the IAEA must be able to count the number of bundle-like objects in the bay and to verify that these are highly irradiated. This task encompasses the generic work required to develop an irradiated fuel verifier for the 600 MWe type CANDU reactor.

PROPOSED SOLUTION:

1) Determine IAEA requirements
2) Design prototype verifier and tools
3) Construct prototype verifier
4) Demonstrate

SCHEDULE AND MILESTONES:

Begin June, 1979, complete June, 1982

PROGRESS:

The design of an irradiated fuel verifier was based on the principle of verifying gross gamma emission characteristics of the fuel. Assessment was also made of the relative merits of using Cerenkov radiation as a substitute technique to replace the gross gamma verifier. Preliminary results indicated that Cerenkov radiation would be a good attribute to verify. A verifier has been developed which tests for Cerenkov emission rather than gross gamma emission. This task has been terminated.

PLANNED COMPLETION DATE:

Completed

FUNDING:

Through 1983/84 - $ 48,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-5

TITLE: Provision of an Irradiated Fuel Verifier for Pickering-A Station

PARTICIPATING ORGANIZATIONS: AECL/AECB

IAEA PROJECT OFFICER:

PROBLEM:

Irradiated fuel at Pickering A station must be verified.

PROPOSED SOLUTION:

Produce an irradiated fuel verifier suited to the Pickering A station storage bay. Assistance will be provided to the IAEA to:

1) Determine the IAEA requirements
2) Design verifier and tools
3) Construct verifier and tools
4) Install and test verifier

SCHEDULE AND MILESTONES:

Start August 1977, complete August, 1978

PROGRESS:

A gross gamma-type irradiated fuel verifier has been completed, installed and is now being used. Some modifications have been made based on suggestions afcer operating experience with the verifier.

PLANNED COMPLETION DATE:

Completed

FUNDING:

Through 1983/84 - $ 90,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: V-7

TITLE: Evaluation of Light Amplification Techniques Applied to Cerenkov Glow as an Attribute Test for Irradiated CANDU Fuel

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER: S. Sanatani

PROBLEM:

The IAEA requires a system that will determine whether or not bundles in the spent fuel bay are irradiated CANDU fuel bundles. The ideal system will result in a minimum disruption of the operator's program of fuel handling. The light amplification techniques utilizing Cerenkov radiation need to be tested to determine their effectiveness when applied to CANDU fuel bundles.

PROPOSED SOLUTION:

To assist the IAEA to evaluate the effectiveness of techniques using the amplification of light from Cerenkov radiation for determining whether bundles in a spent fuel bay are irradiated CANDU bundles. This is to be done for the normal storage conditions, i.e. bundles in both single and stacked storage trays in spent fuel bays. Assistance will be provided to the IAEA in:

1) Arranging for suitable testing of the approach for various bundle stacking arrangements which exist in CANDU stations
2) Assessing, if possible, quantitative measurements of fuel bundles using this method
3) Preparing a report on the effectiveness and possible use by the Agency of this technique for determining if the bundles are actually irradiated fuel bundles and its applicability for quantitative analysis

SCHEDULE AND MILESTONES:

Begin January 1980, complete July 1981

PROGRESS:

Assistance was provided at CRNL to demonstrate the application of Cerenkov radiation verification techniques to CANDU fuel. The results of Task V-7 indicate that Cerenkov radiation could be used as an attribute verification if trays of bundles are isolated from stacks. Work on Cerenkov radiation for use in verifying irradiated fuel in 600 MWe reactors is presently being done under the terms of Task V-8. Further work involving amplification techniques is concentrated in Task V-9.

PLANNED COMPLETION DATE:

Complete

FUNDING:
Through 1983/84 - $ 22,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SC-1

TITLE: Development of CCTV Surveillance System for the 600 MW CANDU Reactor

PARTICIPATING ORGANIZATIONS: AECL-CANDU OPS

IAEA PROJECT OFFICER: P. Vodrazka

PROBLEM:

Surveillance is one of the prime elements in the application of safeguards at 600 MWe CANDU stations. Some areas require CCTV rather than film cameras.

PROPOSED SOLUTION:

Develop a CCTV system suitable for use at 600 MWe CANDUs.

SCHEDULE AND MILESTONES:

Start development : 1978
Complete development : 1982
Complete documentation: 1983

PROGRESS:

A computer controlled system was developed in which the signals from eight TV cameras were stored at intervals on a disc recorder and then transferred to cassette recorders. Redundancy was built in to cope with equipment failures.

PLANNED COMPLETION DATE:

Complete 1983

FUNDING:

Through 1983/84 - $ 690,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SC-2

TITLE: Provision of CCTV Surveillance System for four 600 MW CANDU Reactors

PARTICIPATING ORGANIZATIONS: AECL-CANDU OPS

IAEA PROJECT OFFICER: P. Vodrazka

PROBLEM:

CCTV surveillance is required as part of the application of safeguards at the 600 MWe CANDU stations.

PROPOSED SOLUTION:

Provide a CCTV system suitable for each 600 MWe CANDU station.

SCHEDULE AND MILESTONES:

Complete manufacture : 1982
Complete installation: 1983

PROGRESS:

A CCTV system was installed at each of the four 600 MWe CANDU stations. The performance is adequate for safeguards when the system functions according to design. However, equipment reliability has been a problem. Remedial action is being taken under other tasks.

PLANNED COMPLETION DATE:

Complete - 1983

FUNDING:

Through 1983/84 - $ 1,440,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SC-3

TITLE: Development of Photo-Surveillance Cameras for the 600 MW CANDU Reactor

PARTICIPATING ORGANIZATIONS: AECL-CANDU OPS

IAEA PROJECT OFFICER: P. Vodrazka

PROBLEM:

Surveillance is one of the prime elements in the application of safeguards at 600 MWe CANDU reactors. Film cameras are suitable for use in some areas.

PROPOSED SOLUTION:

Develop a film camera system that will take photographs automatically at intervals as required.

SCHEDULE AND MILESTONES:

Start Development: 1978

PROGRESS:

A system was developed based on the use of a single 8 mm motion picture camera modified for single frame exposures triggered by fixed and random interval timers and by motion and gamma detectors.

Development stopped before the motion and gamma detectors were fully developed, because the Agency decided that these do not form a satisfactory basis for producing safeguards records. Used as a fixed-time triggered unit, the single camera is less reliable than Agency twin Minoltas.

PLANNED COMPLETION DATE:

Complete - 1983

FUNDING:

Through 1983/84 - $ 280,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SC-4

TITLE: Provision of Photo-Surveillance Cameras for four 600 MW CANDU Reactors

PARTICIPATING ORGANIZATIONS: AECL-CANDU OPS

IAEA PROJECT OFFICER: P. Vodrazka

PROBLEM:

Film cameras are required as part of the application of safeguards at the 600 MWe CANDU stations.

PROPOSED SOLUTION:

Provide film cameras for each 600 MWe CANDU station.

SCHEDULE AND MILESTONES:

Complete manufacture : 1982
Complete installation: 1983

PROGRESS:

The film cameras were installed at all four stations. They have proven to be less reliable than the Agency twin Minolta systems. The motion and gamma triggering were not included because they had not yet been fully developed. For these reasons, the Agency has replaced the Canadian supplied cameras with their twin Minolta systems.
1984/85 Spare cameras shipped to IAEA.

PLANNED COMPLETION DATE:

Complete - 1984

FUNDING:

Through 1983/84 - $ 240,000
1984/85 - $ 2,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: FF-1

TITLE: Development of a Fresh Fuel Interrogation Concept for the CANDU Reactor

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER:

PROBLEM:

Development of a fresh fuel interrogator to verify the flow of fresh fuel into the reactor core could be an asset in safeguarding CANDU reactors.

PROPOSED SOLUTION:

Investigate the physical principles to verify the flow of fresh fuel into the core and demonstrate a device in a laboratory situation. Assistance will be provided to the Agency to:

1) Determine the physical attribute to be monitored
2) Determine the strategy of counting and recording
3) Assemble laboratory equipment
4) Demonstrate a device

SCHEDULE AND MILESTONES:

Begin April 1978

PROGRESS:

A feasibility study on the fresh fuel interrogation concept was performed and a report was made to the IAEA. The fresh fuel interrogator was rejected in favor of a simple counting device for the following reasons:

1) extremely high cost
2) difficulty of retro-fitting reactors
3) information to be gained from the device did not appear to be of high enough quality as to be very useful

Work proceeded on development of a fresh fuel counter in task FF-3.

PLANNED COMPLETION DATE:

Complete

FUNDING:

Through 1983/84 - $ 29,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: FF-2

TITLE: Demonstration of a Fresh Fuel Interrogator in a CANDU Reactor

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER:

PROBLEM:

Using the principles of operation demonstrated in FF-1, a prototype will be designed, constructed, commissioned and tested provided the results of FF-1 are positive enough to justify continuing this development.

PROPOSED SOLUTION:

To construct and demonstrate a prototype fresh fuel interrogator. Assistance will be provided to the IAEA to:

1) Design an interrogator
2) Construct an interrogator
3) Conduct operational tests

SCHEDULE AND MILESTONES:

Cancelled

PROGRESS:

This task has been cancelled because of the negative results of task FF-1.

PLANNED COMPLETION DATE:

Cancelled

FUNDING:

Through 1983/84 - $ 0

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: FF-3

TITLE: Development of a Prototype Fresh Fuel Counter for the Bruce-type CANDU Reactor

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER:

PROBLEM:

The IAEA considers that the ability to independently verify the declared flow of fuel charged into the reactor cores for the Bruce type CANDU reactor would constitute an improvement in the safeguarding of both fresh and irradiated fuel for this type of CANDU reactor.

PROPOSED SOLUTION:

Develop and demonstrate a simple counter that could be attached to the fresh fuel loading machine to count the number of fuel bundles charged into the fuelling machine. The device would have some tamper indicating features. The agency would be assisted to:

1) Design the counter
2) Produce a prototype counter
3) Test the counter in as realistic manner as possible in a laboratory environment
4) Install a production prototype at the reactor for field trials

SCHEDULE AND MILESTONES:

Begin December 1979, complete July 1984

PROGRESS:

Preliminary testing and development work has been completed. Laboratory models have been produced and tested satisfactorily. A prototype was constructed and demonstrated to the IAEA in February 1981. Suggestions for minor improvements were completed and the unit was re-demonstrated at IAEA headquarters, Vienna, in March 1981. A report has been written describing the monitor and the results of the laboratory tests. The final version of the prototype monitor has been constructed and demonstrated. The production prototype underwent field tests from April to July 1984. Documentation for the device has been completed.

PLANNED COMPLETION DATE:

Complete - August, 1984

FUNDING:

Through 1983/84 - $ 320,000
1984/85 - $ 36,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: HW-1

TITLE: Study to Investigate the Safeguards of Heavy Water

PARTICIPATING ORGANIZATIONS: AECB-AECL

IAEA PROJECT OFFICER:

PROBLEM:

Heavy water is one of several moderators that can be used in a reactor thereby indirectly contributing to the production of fissile material.

PROPOSED SOLUTION:

Assist the IAEA to:

1) Determine how heavy water is normally used and handled in operating power reactors
2) Establish criteria for the verification methods
3) Enumerate in detail verification methods, procedures and instrumentation

SCHEDULE AND MILESTONES:

Begin August, 1977
Complete September, 1980.

PROGRESS:

A study was completed. A report was written and sent to the IAEA on this subject. The study is now considered complete.

PLANNED COMPLETION DATE:

Complete

FUNDING:

Through 1983/84 - $ 12,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: OR-1

TITLE: Study of the Use of Reactor Operating Records and Instrument Data for Verification of the Declared Core Inventory and the Flow of Fuel Through the Core

PARTICIPATING ORGANIZATIONS: AECL/Ontario Hydro

IAEA PROJECT OFFICER:

PROBLEM:

Nuclear material in the core of CANDU reactors is inaccessible and cannot be directly verified with any of the normal techniques available to IAEA inspectors. Process parameters may be useful for qualitative determination of the core inventory or fuelling operations. A study of the use of reactor operating records and instrument data is required to determine their applicability to the verification of the declared core inventory and the flow of fuel through the core.

PROPOSED SOLUTION:

Phase 1

1) Determine what instrument data or core parameters are available and could be provided to the IAEA inspectors
2) Determine the usefulness of each data type, either singly or in combinations, providing a qualitative indication of core inventory for fuelling operations
3) Determine the sensitivity of the indications given including effects on the data from typical operation conditions and whether such effects can be overcome

Phase 2

1) Determine how the data identified in Phase 1 can be obtained, managed and digested and presented to the IAEA inspectors
2) Identify methods of verifying the data identified in Phase 1
3) Estimate the manpower required to use the data effectively

SCHEDULE AND MILESTONES:

Begin July, 1981

PROGRESS:

Phase 1 of the task has been completed, a draft report has been written and sent to the IAEA for comment, comments have been made by the IAEA and were considered by Canadian experts. The task is considered complete.

PLANNED COMPLETION DATE:

Complete 1985

FUNDING:

Through 1983/84 - $ 31,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: CV-1

TITLE: Verification of the Fuel Inventory Contained in a Reactor Core

PARTICIPATING ORGANIZATIONS: AECL/Ontario Hydro

IAEA PROJECT OFFICER:

PROBLEM:

The IAEA has proposed the discharge of a statistically significant number of fuel channels to verify the number of fuel bundles contained in a CANDU reactor core. An examination of the technical feasibility and cost involved in this approach is required.

PROPOSED SOLUTION:

Study the technical, operational and economic implications of the proposal to verify the fuel inventory contained in a CANDU reactor core.

SCHEDULE AND MILESTONES:

Begin April 1981, complete November 1982

PROGRESS:

A draft report has been completed and issued to the IAEA regarding these findings. The report proposes two methods for the verification of the reactor core. One method involves the discharge of a statistically selected number of fuel channels to verify the number of fuel bundles contained in the core. The second method proposes a statistical sample plan to verify the core but the actual verification of fuel bundles occurs only when the selected channel is discharged according to the regular fuelling schedule. After discharge the irradiation history of the bundles would be determined to verify the operator's records by using NDA techniques.

PLANNED COMPLETION DATE:

Complete

FUNDING:

Through 1983/84 - $ 24,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: FM-1

TITLE: Study to Investigate Means of Determining the Fissile Material Content of Spent Fuel Bundles

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER:

PROBLEM:

As a back-up measure to the primary containment and surveillance measures at irradiated fuel storage bay for CANDU power stations, the Agency may require a method to determine the fissile material content of irradiated fuel bundles.

PROPOSED SOLUTION:

Determine a practical inspection method for determining the fissile material content of spent fuel CANDU bundles. Provide assistance to the IAEA to:

1) Identify potential methods
2) Evaluate the potential methods for accuracy, ease of application, hardware cost, obtrusiveness, vulnerability, etc.
3) Develop a technique and design for the most promising method

SCHEDULE AND MILESTONES:

Begin September, 1978
Complete January, 1980

PROGRESS:

A report was written and sent to the IAEA. The results of the study for points one and two indicated that there was no further development required beyond Agency techniques currently practiced. The task is complete.

PLANNED COMPLETION DATE:

Completed

FUNDING:

Through 1983/84 - $ 3,000

CANADIAN SAFEGUARDS R & D IN SUPPORT OF IAEA

TASK NO: SS-1

TITLE: Study to Investigate Unique CANDU Bundle Identification

PARTICIPATING ORGANIZATIONS: AECL

IAEA PROJECT OFFICER:

PROBLEM:

The current safeguards approaches for CANDU reactors entail the use of containment and surveillance to counter many of the diversion paths. The Agency felt that a unique identification of each CANDU bundle would establish accountancy as a prime safeguards tool and possibly reduce the safeguards cost and effort from the containment and surveillance approach. A study is required to determine the feasibility of unique CANDU bundle identifiers.

PROPOSED SOLUTION:

1) Review the state-of-the-art of unique identifier concept, especially ultrasonic pattern recognition of inclusion in welds
2) Consider means to incorporate unique identifiers as integral components of each fuel bundle. Estimate the incremental manufacturing cost associated with the operation. Assess potential safety problems associated with the addition of the identification through the life cycle of the fuel bundles
3) Determine engineering specifications for readers, including bundle handling requirements. Include a data file generator noting, as a minimum, reader identity, identity pattern observed, date, and time of reading. Estimate cost per unit including development. Consider schemes to read bundle identifiers in-situ, storage racks
4) Estimate the requirements, cost and times for a pilot test program
5) Prepare a summary report

SCHEDULE AND MILESTONES:

Begin June, 1978

PROGRESS:

The study on unique CANDU bundle identification has been completed and a copy of the report sent to the IAEA. The result of the report is that the techniques studied were not feasible to use in unique CANDU bundle identification. The task is considered complete.

PLANNED COMPLETION DATE:

Complete

FUNDING:

Through 1983/84 - $ 13,000